

PSN Service Manual for Antistatic Measures

Purpose: To take measures for preventing electrostatic faults in semiconductor devices

Scope: Applicable to all PSN service points and local service points outside Japan

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1. Necessity of Antistatic Measures

The electrostatic breakdown voltages of semiconductor devices are as low as shown in the table below. Therefore, the probability of damaging semiconductor devices by static electricity generated around human bodies or repairing benches is very high.

This manual summarizes the minimum antistatic measures necessary at the PSN repairing points with examples.

1.1 Semiconductor Devices and Electrostatic Breakdown Voltages

Device type	Breakdown voltage range (V)
VMOS	30 to 1,800
MOS FET	100 to 200
GaAs FET	100 to 300
EPROM	Below 100 V
JFET	140 to 7,000
SAW	150 to 500
OP-AMP	190 to 2,500
CMOS	250 to 3,000
Schottky Diodes	300 to 2,500
Film Resistors	300 to 3,000
Bipolar Transistors	380 to 7,000
ECL	500 to 1,500
SCR	680 to 1,000
Schottky TTL	1,000 to 2,500
XM satellite tuner unit	Below 10 V
Pickup	Below 30 V

* The breakdown electrostatic voltage of an IC depends on the IC type.

1.2 Human Actions and Body Charged Potentials

Human action	Body charged potential (kV)	Remarks
Walking on a nylon carpet	2.0 to 2.5	Sneakers
Shuffling on a nylon carpet	>4.5	Sneakers
Rising from a sofa	3.5 to 4.5	Clothes: Rayon and cotton
Taking off an acrylic sweater	4.5 to 5.0	Underwear: Acrylic
Taking off polyester working clothes	4.0 to 4.5	Clothes: Rayon and cotton
Folding an acrylic blanket	5.0 to 6.0	

* A human is a moving object that is charged with a static potential.

* A little action or a friction with an insulator generates static electricity easily.

* A human feels a discharge only if the charge level is within 2 to 3 kV.

2. Basics of Antistatic Measures

2.1 Basic Concept of Antistatic Measures

- (1) No electrostatic generation
Minimize the static electricity even if generated.
- (2) No electrostatic charging
Ground generated static electricity immediately to prevent retention.
- (3) No electrostatic discharging
Do not cause an electrostatic discharge at a specific place.
- (4) Shielding
Shield a device to avoid influences from an approaching charged article and generated static electricity.
- (5) (1) to (3) are methods of eliminating the causes of electrostatic faults and (4) is a method of guarding devices from electrostatic faults.

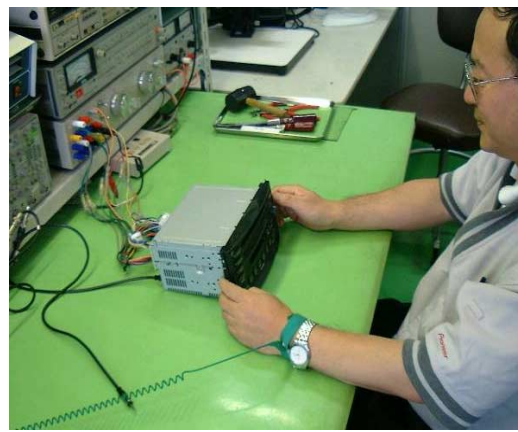
2.2 Basic Rules of Antistatic Measures

- (1) Arrangement of working environment
Minimize the static electricity even if generated.
- (2) Grounding of human body
Discharge a human body for parts sensitive to static electricity.
- (3) Arrangement of containers for transportation or storage
Transport or store electrostatically sensitive parts under a charge-free environment.
- (4) Arrangement of work manuals, etc.
Educate workers and make maintenance rules.

2.3 Antistatic Repairing Benches and Scenes of Repairing Work



Arranged repairing bench



Repairer wearing antistatic working clothes and a wrist strap

3. Antistatic Measures for Service Bench

* Execute the actions of 3.1 to 3.8 securely to protect the PSN service bench from static electricity.

3.1 Outlet Grounding Check (See Section 4.)

- Check grounding as explained in Section 4.B6
- Be sure to use a power cord with three-brade sockets when necessary.

3.2 Antistatic Measures for Service Floor (See Section 6.)

- Lay a conductive floor mat under the repairing bench and floor for grounding.
- When connecting floor mats, lay a copper plate under the mats and seal the joints with conductive tape.

3.3 Antistatic Measures for Repairing Bench (See Section 5.)

- Lay a conductive mat under the repairing bench and connect one end of the mat to the ground terminal of an outlet for grounding.
- Attach a ground electrode to the conductive layer (black) side on the back of a conductive mat handled by the WP C.
- For the ground electrode, use a T-shaped metal bracket (available from DIY centers for wood-working). When securing the metal bracket on the mat, use self-locking pins for compact attachment.
- Keep conductive mats clean because they become less effective if their surfaces become dirty.

3.4 Antistatic Measures for Measuring Instrument and Tools (See Section 8.)

- Connect the ground terminal on the back of a measuring unit on the bench to a ground terminal.
- Be sure to use an antistatic soldering iron or solder eliminator of a high insulation type with grounding.

3.5 Conductive Container for Parts and Tools (See Section 9.)

- Use a metallic container (made of stainless steel or other) for parts or tools with a conductive mat on the bench.

3.6 Arrangement of Bench

- Keep the repairing bench free of unnecessary things on the works surface.
- Keep plastic vinyl bags and other easily charged objects our of the way.

3.7 Static Measures of Human Body

3.7.1 Using conductive shoes

- Use conductive shoes with conductive mats.
- Keep conductive shoes clean because they become less effective if the soles become dirty.

3.7.2 Using a wrist strap

- Be sure to attach a clip to the ground line securely.
- Always attach a wrist strap to the skin.
- Keep a wrist strap on during work.
- Check a wrist strap for a line cut periodically. (Internal resistance: 1 MW)

- Using a seat mat

Compared with a wrist strap, an antistatic seat mat is easy to attach and almost as effective. However, an antistatic seat mat must be made by the user himeself/ herself. (See Section _ for how to make it.)

3.7.3 Repairer's clothes

- Wear antistatic working clothes for work.
- For repairing, do not wear clothes made of a textile easily charged with a static potential (chemical fiber or other).

3.8 Antistatic Area

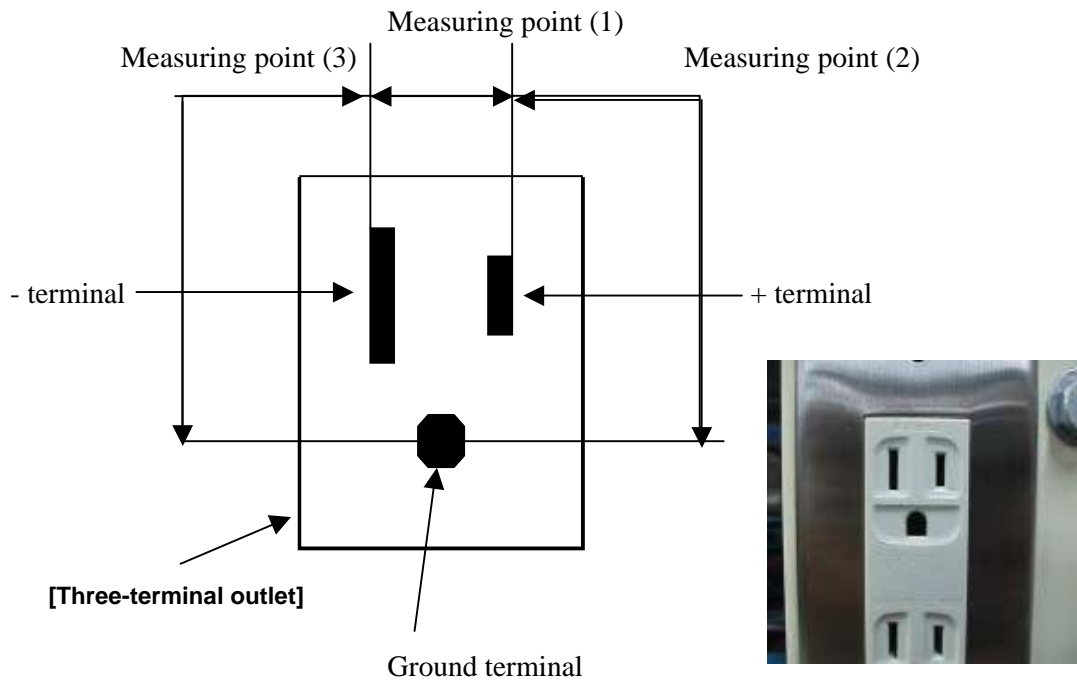
- Identify an antistatic area by color taping.
- When entering an antistatic area, prevent static electricity by using antistatic working clothes and conductive shoes.

4. Grounding and AC Outlet

4.1 AC Outlet Check

Before connection to a power outlet, check potentials at the measuring points shown below.

Measuring instrument: AC voltmeter (multimeter)



4.2 Judgment of Measurement Results

Measuring position	Contents of measurement	Measured value and tolerance
(1)	Power supply voltage check Voltage between the + and - terminals	100 VAC (Tolerance: +7 to -5%)
(2)	Power supply, voltage, polarity, and grounding effects Voltage between the + and - terminals	100 VAC (Tolerance: +7 to -5%)
(3)	Power supply, voltage, polarity, and grounding effects Voltage between the + and - terminals	0 VAC (Tolerance: 5 V or less)

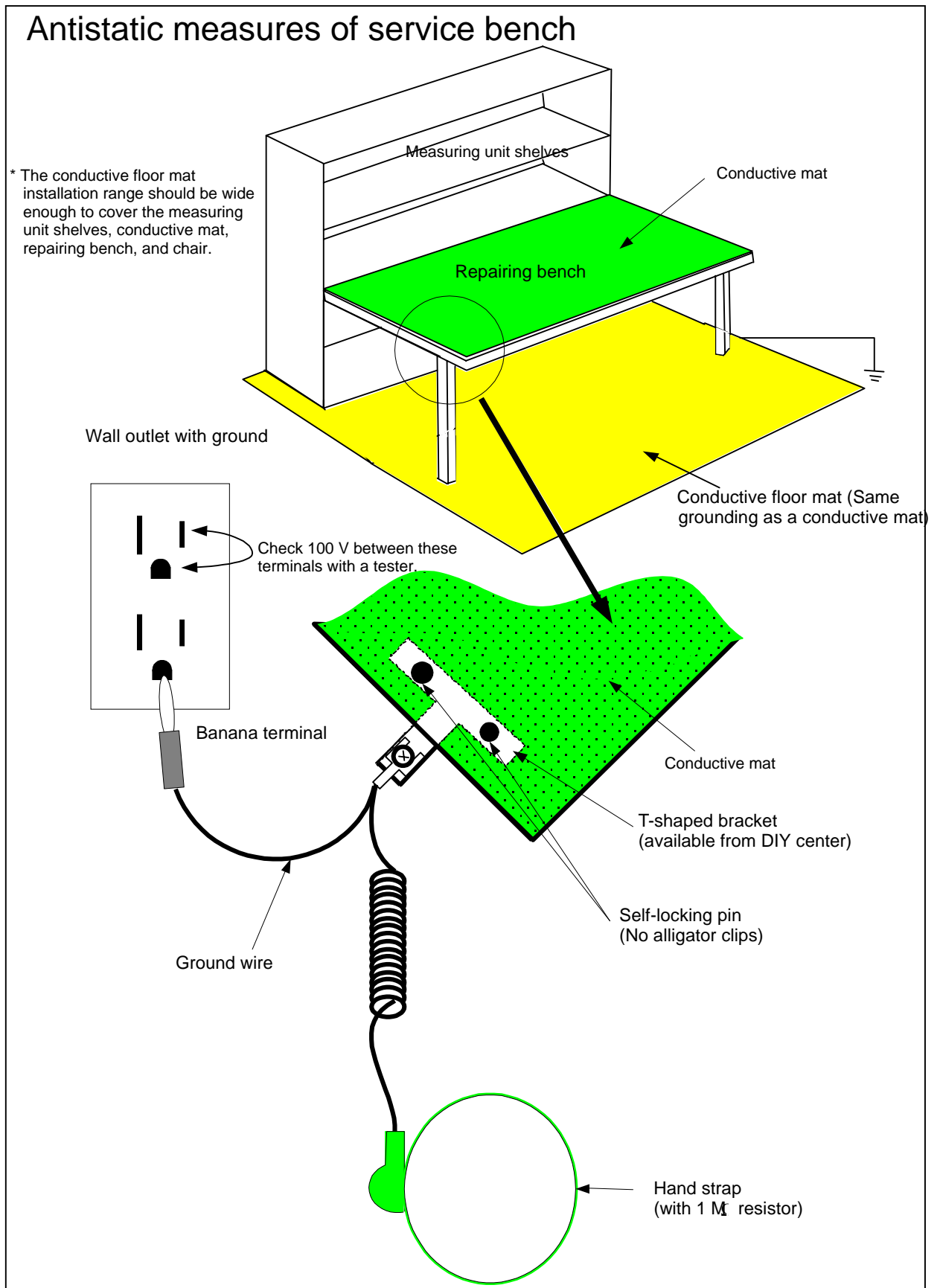
Action taken for a result out of tolerance

If a measurement result does not satisfy the corresponding tolerance, there may be a wiring error or connection failure. Take immediate action.

4.3 Wall Outlet with No Ground

- (1) A power distributing board (ground line) or ferroconcrete building may be used for grounding.
- (2) If (1) is not possible, drive several ground bars (purchased from an electric materials store) into the ground.

5. Taking Antistatic Measures on Service Bench



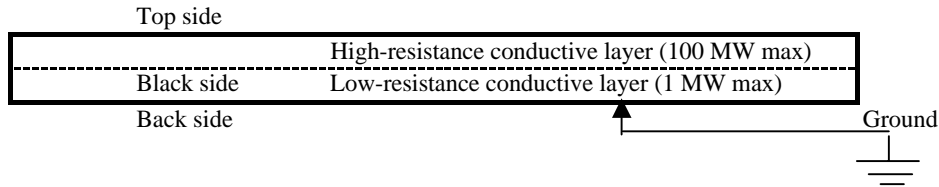
6. Installation of Conductive Mat

6.1 Conductive Mat Grounding Method

Grounding helps a conductive mat eliminate a static potential.

To each mat, be sure to attach electrodes and connect ground wires.

Electrodes should always be attached to the low-resistance conductive layer (1 MW) on the back of a conductive mat.

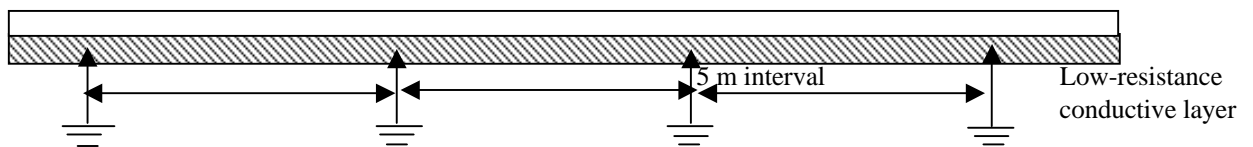


Note:

Attachments to the high-resistance conductive layer cannot eliminate a static potential effectively because of high resistance.

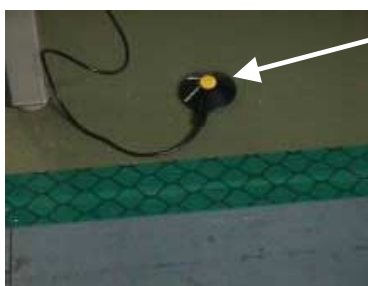
6.2 Interval of Electrode Attachment to Conductive Mat

Attach a connection electrode and connect a ground wire every 5 m unless specified otherwise, although this depends on the mat type.



6.3 Electrodes and Their Attachments to Conductive Mat

a) Connection electrode made by 3M

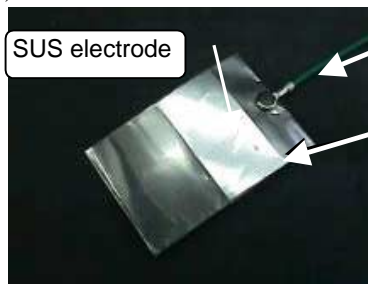


Electrode (from the top side)



Electrode (from the back side)
Put the claw through the low-resistance conductive layer from the back of the mat and bend it for joining.

b) Connection electrode made by Achilles

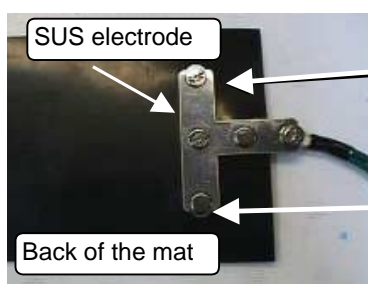


SUS electrode

Lead wire

Double-side adhesive tape for attachment
Peel off the backing and stick the tape to the low-resistance conductive layer.

c) Electrode with general-purpose bracket



SUS electrode

Back of the mat

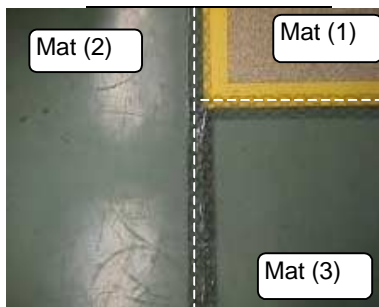
Attach the electrode to the low-resistance conductive layer from the back of the mat.

Attach with a self-locking pin (for lead wire connection).
Use a crimp terminal at the tip of the lead wire.

Attach with a self-locking pin
(two or more for mat connection).

7. Connections of Conductive Floor Mats (Mat to Mat)

A) Using inter-mat connection plates (made by Achilles)



In the figure at left, three mats are laid.

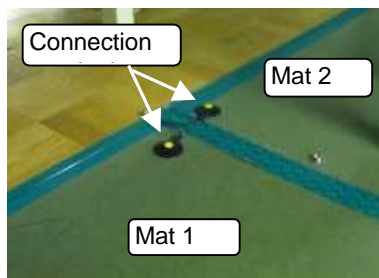
Connection method

Attach dedicated electrodes to the low-resistance conductive layer of mat 1 and connect ground wires.

Attach dedicated electrodes to the low-resistance conductive layer of Mats 2 and 3 and connect ground wires.

The electrodes shall be attached and connected to ground wires at 5 m intervals.

B) Using inter-mat connection terminals (made by 3M)



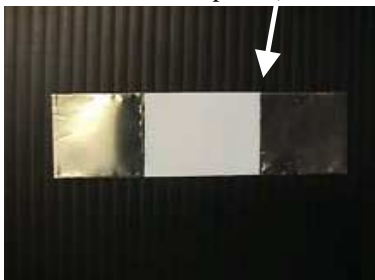
Connection terminals are used to set up continuity between the mats.

Note:

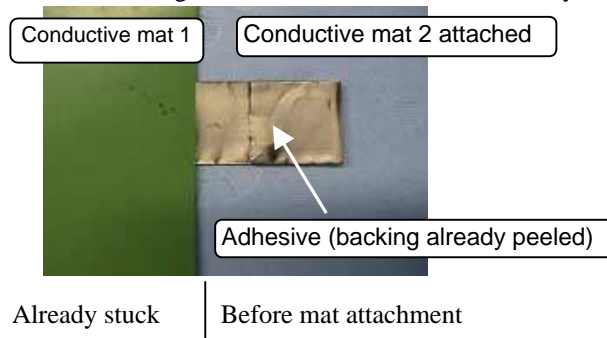
The mats should be grounded at 5 m intervals.

C) Using inter-mat connection terminals (made by Achilles)

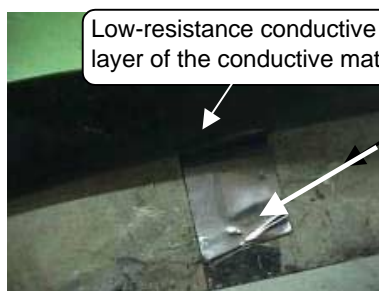
Connection plate (with backing)



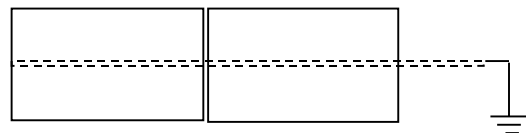
Sticking to the low-resistance conductive layer of the mat



D) Using SUS inter-mat connection electrode belt



The SUS electrode belt is contacted with the low-resistance conductive layer for continuity.



Note:

Be careful about bad contact.

It is recommended to use self-locking pins for joining.

E) Mat surface joint treatment



The mat surface joints are treated with conductive adhesive tape, like the connection plates on the back.

Manufacturer: Achilles

Product: Conductive tape

Model: ST polyester IC tape

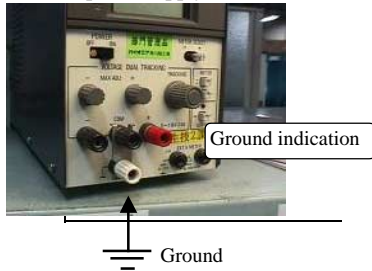
Price: ¥2,800

8. Grounding of Measuring Instruments, Jigs, and Tools

- Unless specified otherwise, equipment not grounded with a power cable (3P plug with ground) shall be grounded through an added ground wire for physical protection (electric shock prevention) and prevention of surge destruction.

Note: If the signaling system is grounded or different instructions are given in specifications, this connection is not necessary because it causes an operational fault.

a) For a DC power supply

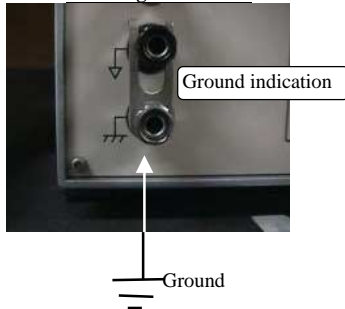


If the power cable has a 2P plug with no ground, connect a dedicated ground wire for grounding.

When not grounded

- The cabinet and DC output terminal generate an AC voltage.
- Surge destruction may occur because the surge filter in the power supply section does not occur.

b) For a measuring unit

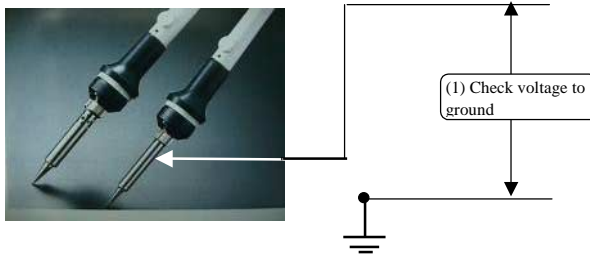


Unless specified otherwise, connect a ground wire to the ground terminal.

When not grounded

- Do not ground the unit if the signaling system is grounded.
- Measure the voltage to ground of the cabinet. If the voltage is abnormal, contact the person in charge of antistatic measures or the administrator for immediate action.

c) For a soldering iron



For high insulation type, judge with (1) because the resistance cannot be measured.

Limits on soldering iron:

Use an antistatic soldering iron of a high insulation type in the production process.

Measuring notes

1. Measure the leakage to ground because a soldering iron may have current leakage at the tip.
2. If the tip is not grounded, substitute (1) for the continuity check.

d) For a solder absorber



Measure a solder absorber in the same way as a soldering iron.

- High insulation type
Measure the voltage to ground.
- General type
Measure the voltage to ground.
Measure continuity with the ground.

Measuring notes

- High-insulation solder absorbers are provided to prevent surge destruction. To avoid the risks of surge destruction, however, check the voltage to ground at the absorbing tip.
- Many solder absorbers are not designed against static electricity. When using a solder absorber, avoid risks by grounding and inspection to ensure safety.
- A solder absorber with a 2P power cable is not designed against static electricity. Secure grounding.

9. For Parts Tray or Trash Box

Using a metal parts tray



A metal parts tray does not require grounding because it is usually not charged.

If there is a risk of contacting semiconductor-mounted parts, however, ground the tray.

Reason:

The tray functions and stores a potential like a capacitor. Grounding will release the potential.

Using a metal trash box



A metal trash box does not require grounding because it is usually not charged.

(There is no risk of contacting semiconductor-mounted parts.)

Even when there are charged things inside, the static shielding effect reduces the risk.

10. Antistatic Measures by Conductive Shoes

Always use conductive shoes with conductive mats.



Example 1

Manufacturer:

Midori Anzen Co., Ltd.

Product:

Elepath Cool

Model:

No.21001014

Example 2

Manufacturer:

Achilles Corp.

Product:

IC Shoes

Model:

ICM-2100 (Male)

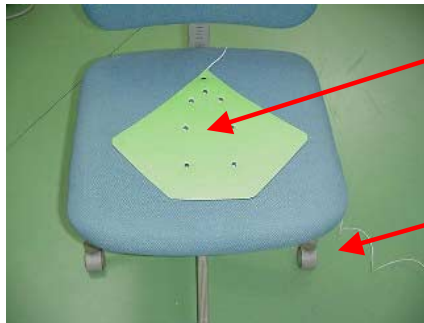
ICL-2101 (Female)

11. Creation of Antistatic Seat Mat

* Since a wrist strap is put on or removed according to the work and circumstances, a worker may forget to put on a wrist strap when necessary.

The antistatic seat mat shown below can replace a wrist strap because it is comparatively easy to create, has a proven effect, and need not be put or removed.

[1] Appearance



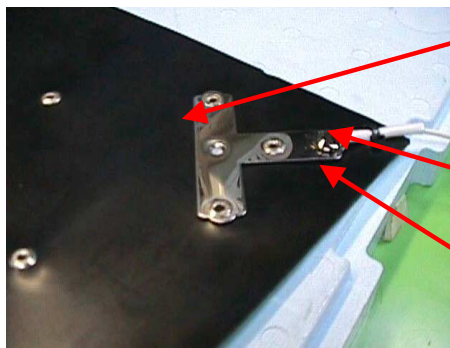
Self-locking pins are added to reduce the contact resistance.

The ground wire had better be green or black but white here to prevent a catch.



The self-locking pins to reduce the contact resistance are pierced from the back of the conductive mat and caulked.

[2] Connection



The electrodes are ordinary T-shaped brackets (made by Doit, 90 yen).
Three self-locking pins are used for connection.

To protect the ground wires:

- (1) Adding a vinyl tube
Insert a marking tube into the terminal crimping section for convenience.
- (2) Boring holes in the mat and bundling the wires with lock ties

[3] Mat

Use an electrostatic mat for a table.

A mat is either for a floor or a table.

- A floor mat is rigid enough to withstand a load but will melt if touched with a soldering iron.

[4] Notes on use (Always check)

(1) Since a human body changes resistance, measure the value with a person seated.

(2) Resistance judgment criteria

Protective resistance may be unnecessary (but may be inserted when necessary) because even the minimum value is about 500 k Ω .

The maximum value is 100 M Ω (at present).

The values are the same as when shoes are used. A system analyzer may indicate 100 M Ω .

(3) Continuity failure

Use a wrist strap instead.

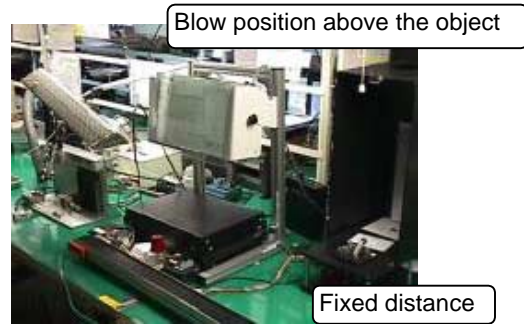
12. Prevention of Charging by Static Eliminator (Effective for Charge Elimination in a Narrow Range)

Permanently polarized resin parts (grill, cover, and other) may be charged more than prescribed.
To prevent electrostatic problems, neutralize the material potentials with a static eliminator.

Although there are many kinds of static eliminators, an AC voltage applied type is recommended.

- Reasons:
- Since ions of both the positive and negative polarities are generated, this type can be used for a charged object of any polarity.
 - The static elimination performance is high and an optimum one can be selected from many models in the market according to the charged object.

12.1 Example of Static Elimination



12.2 Notes on Using Static Eliminator

- Be sure to ground the static eliminator.
Grounding supports static elimination and ensures safety at current leakage from inside where a high voltage is generated.
- Install the static eliminator at an appropriate effective distance.
The effective position is for blowing from above.
- Maintain performance by periodic maintenance.
 - Clean the emitter terminal at least once every six months and replace it if worn.
 - Clean the filter.If the filter becomes dirty, the blow rate goes down and the quantity of ion generation decreases.
Clean the filter at least once a month.
- Check the ion balance.
 - To confirm the effect of static elimination, measure the charge voltage of an object first and check that the voltage goes down to near 0 V within several seconds of ion application.

13. Measurement of Electrostatic Potential

- For electrostatic potential measurements, the following units are available:

Manufacturer: Shishido Electrostatic, Ltd.

Product: Electrostatic potential measuring unit

Model: Statiron DZ3

Price: ¥80,000



Manufacturer: Kasuga Electric Works, Ltd.

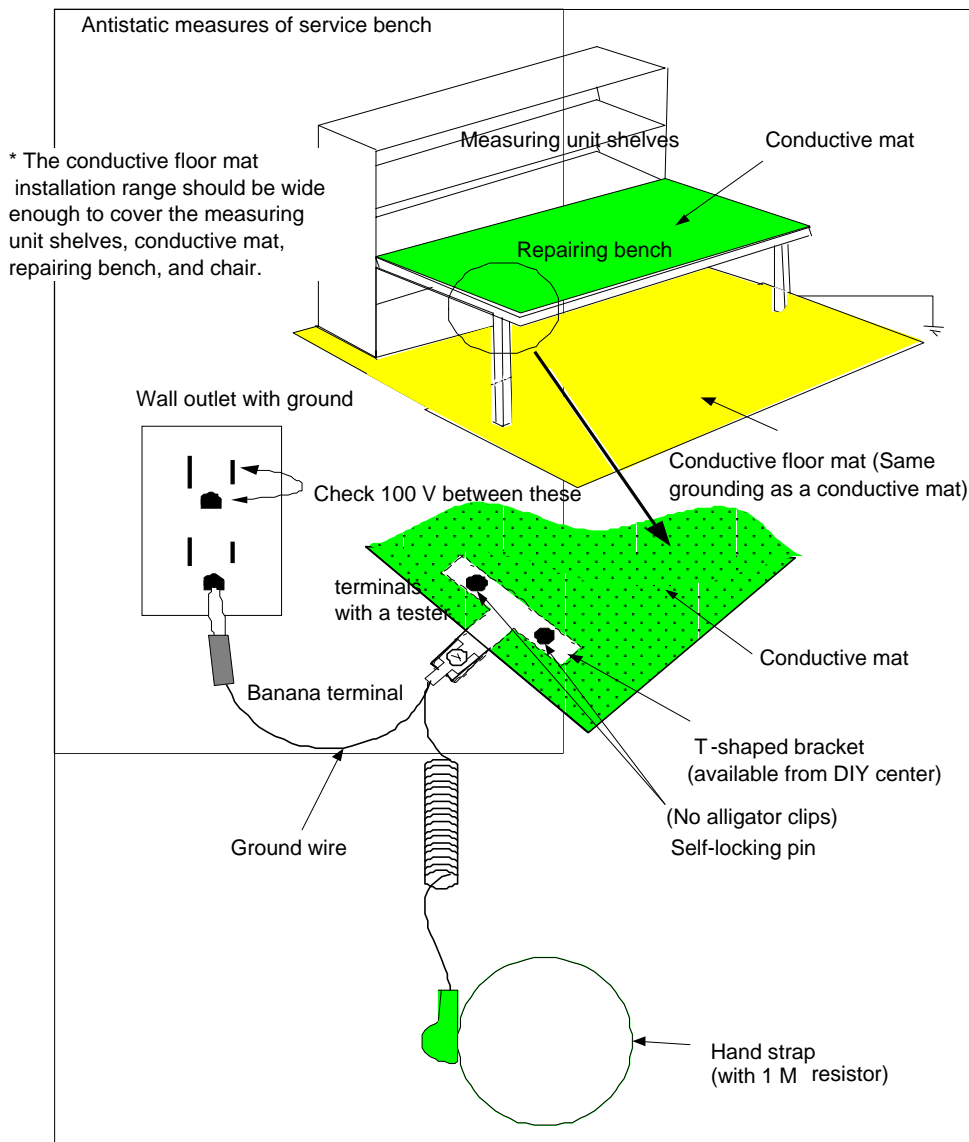
Product: Digital low-potential measuring unit

Model: KSD-0202

Price: ¥83,300



14. Costs of Antistatic Measures for Service Bench



The antistatic measures for one bench costs the following:

Equipment: About 34,000 yen
Installation: None
(if installed by customer.)

Approximate costs of antistatic measures per bench (not including installation)

Item	Vendor	Product No.	Size	Unit price of bench	Q'ty	Bench floor area	Purchase price/Unit	
							Expenses	Unit of purchase
Conductive floor mat	(Achilles)	SKY-8W	2.0T x 1,820W mm	21,000	1	1.8m x 1.8m	280,000	20 m roll
Conductive bench mat	Selected jig	GEX1002	1m x 1.8m	15,480	1		86,000	10 m roll
Wrist strap	Selected jig	GDD1010		1,010	1		1,010	1
Conductive tape	(Achilles)	ST polyester IC tape	50W mm x 50L m	2,800	1		2,800	1
Conductive shoes	(Achilles)	ICM-2100		4,500	1		54,000	12 pairs/case
Power cord with three-blade sockets				1,000	2			
Small equipment				2,500	1			
Continuity plate for mat	Achilles	SKY-8T	Stainless-steel ground plate (30mm x 100mm)	500	2		2,500	20/case
Ground wire for mat	Achilles	SKY-8E	Ground plate with ground wire	400	1		4,000	10/case
Total(ven)				33,710				

* The current service jacket will be used as antistatic clothes.